Week 49 Influenza Forecast for the 2012-2013 U.S. Season

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Abstract

We present results of a forecast initiated Week 49 (beginning December 9, 2012) of the 2012-2013 influenza season for municipalities in the United States. The forecast was made on December 14, 2012. Results from forecasts initiated the two previous weeks (Weeks 47 and 48) are also presented. Also results from the forecast generated with the SIRS model without absolute humidity forcing (no AH) are shown.

1 Retrospective Forecast

Retrospective forecast skill is calculated for individual cities, as well as for census region in aggregate, and all cities (excluding the pandemic years 2008-2009 and 2009-2010, which will need to be handled separately in the future). The forecast methods are similar to those described in Shaman and Karspeck (2012). Based on the relationship between prediction accuracy and ensemble spread of these retrospective forecasts we can assign calibrated confidences to our current predictions.

Some cities work well in isolation (St. Louis, NYC–not shown), others do not. The question is whether the good and bad cities should simply be aggregated by region, which would suggest that the predictability is really the same among them, but the sample size for an individual city is too small (too few years). Or is it that the statistics are robust and that predictability varies among cities due to differences in local population size, population age structure, geography and connectivity among individuals, etc. We don't know the answer to this question yet, so for now will give certainty estimates based on the local/municipal record, the regional aggregate and the national aggregate.

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Figure 1 shows the results for all cities in aggregate using climatological AH and a factor of 5 mapping. Overall the relationship is informative; however, for all lead times there is a basic plateau of skill once the ensemble log variance drops below 2.5 to 3 weeks^2.

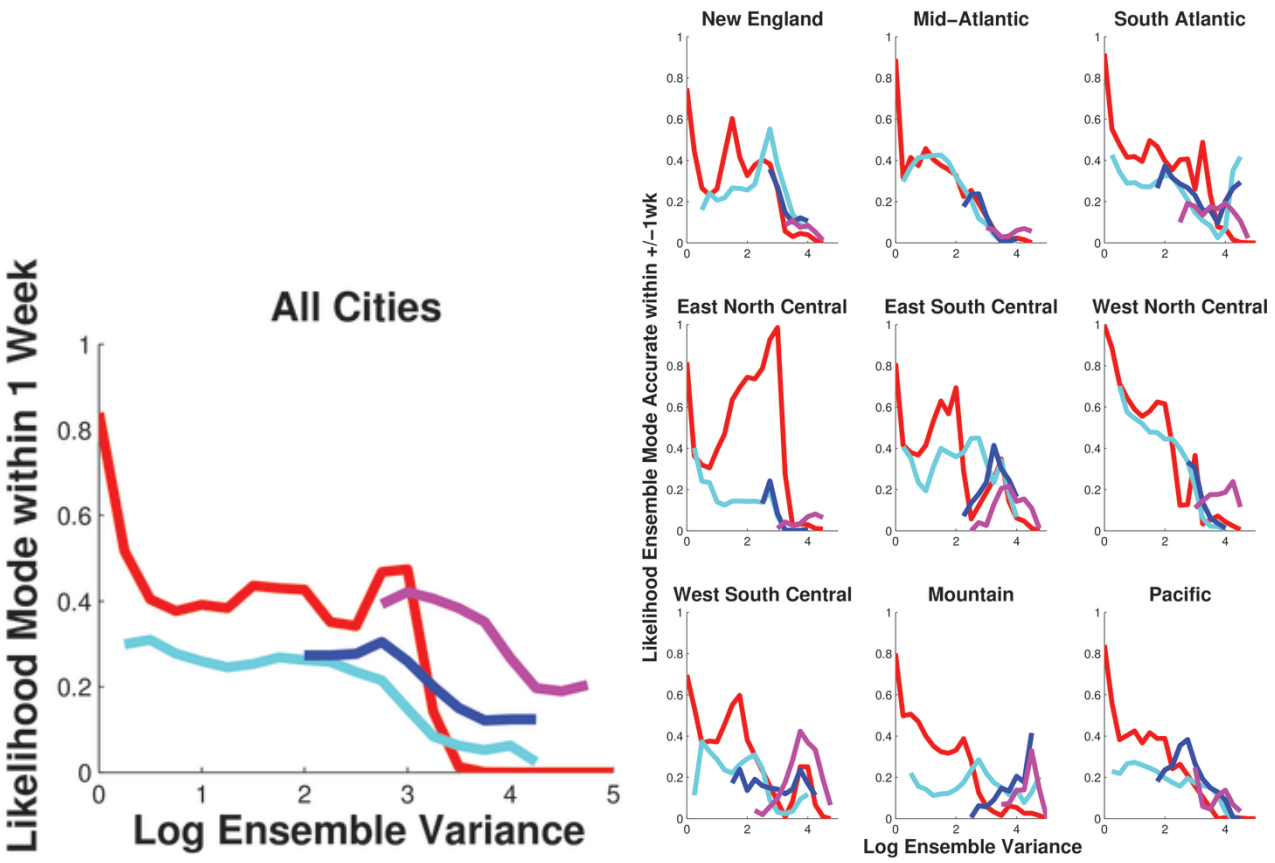

Figure 1: Plot of ensemble mode forecast accuracy versus ensemble spread measured as log ensemble variance +1. Left) 114 cities in aggregate. The runs are binned in increments of 0.25 units and stratified by forecast lead time: 1-3 weeks (red), 4-6 weeks (cyan), 7-9 weeks (blue), 10+ weeks (magenta). Right) Same as left, but the 114 cities grouped by census region.

When the cities are grouped by region, there is some heterogeneity. Some regions (e.g. West North Central) show marked improvement of forecast accuracy/skill with decreasing spread across all lead times. Other regions show much more limited skill–the Mountain region only has skill at 1-3 weeks, and the East North Central has problems at 1-3 weeks.

2 2012-2013 Forecast

2.1 Week 49 Forecast

The Week 49 forecast (initiated December 9, 2012) basically stays on track with predictions made in prior weeks. Atlanta and Chicago are all predicted to be at peak ($\pm$1 week) during week 49

(Figure 2), which is the week ending December 8, 2012. Basically, these forecasts predict no future week higher then that latest observed week. Dallas is forecast to predict in 0-1 weeks. Houston and Memphis are forecast to peak in one week (the week ending December 15, 2012). The calibrated confidence in these predictions is fairly high ($> 50\%$, except Memphis at the municipal scale).

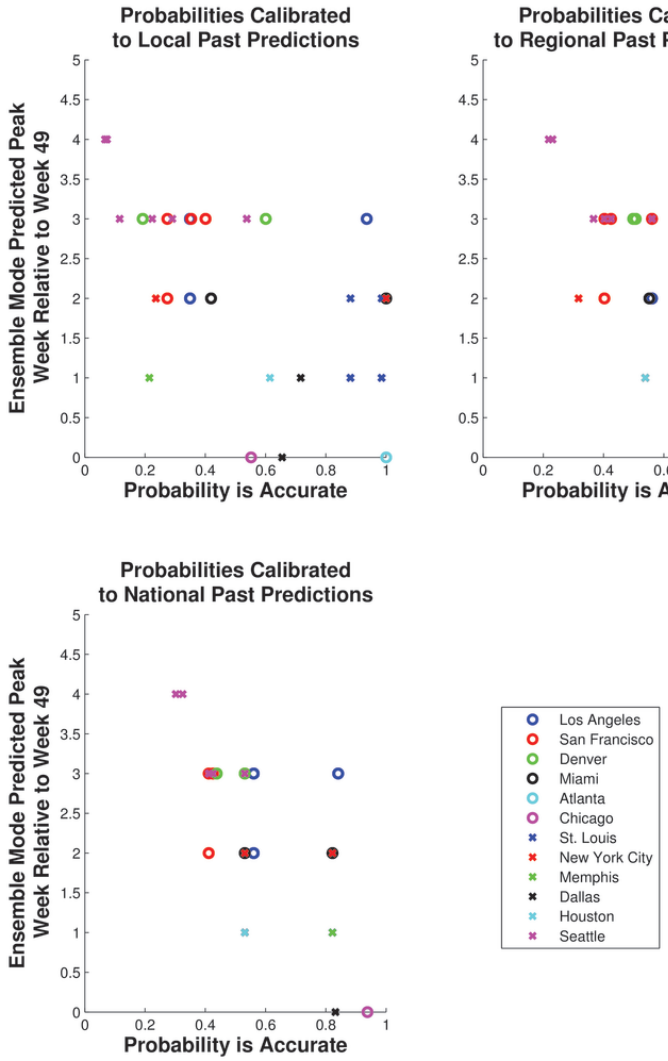

Figure 2: Ensemble mode peak week predictions relative to Week 49 for 12 cities plotted as a function of probability/confidence calibrated from historical city, regional and national prediction accuracy. Forecasts were initiated the beginning of Week 50 (December 9, 2012).

St. Louis is predicted to peak in 1-2 weeks. Miami is now predicted to peak in 2 weeks, as is New York City. The New York City prediction is a change of 2-3 weeks from the prior week (Week 48) prediction of peak in 4-5 weeks. Both Los Angeles and San Francisco are forecast to peak in 2-3 weeks. Denver is predicted to peak in 3 weeks (with about 50% confidence). Seattle is predicted to peak in 3-4 weeks. Figure 3 shows histograms of these predictions.

Most of these changes are shifts in the prediction of 1 week from the prior week prediction, indicative of a similar tracking of outbreak evolutions. New York City had a larger shift of 2-3

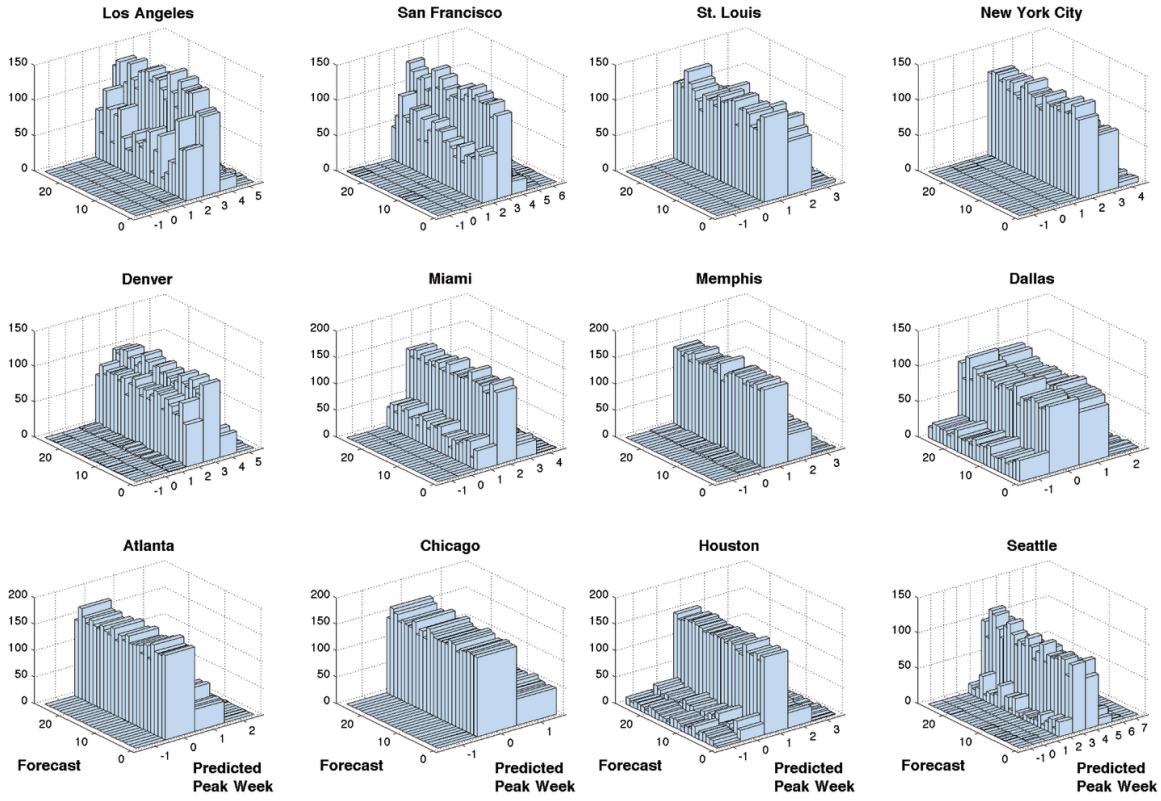

Figure 3: Left) Histograms of the best ensemble start date trainings for forecasts made beginning the start of Week 50 (December 9, 2012) for select cities. The distributions show the ensemble spread among peak predictions. Week 0 is Week 49.

weeks. (Indeed, two weeks ago, New York City had a peak predicted to be 6-7 weeks in the future; so the forecast trajectory has shifted.) From the histograms, it can be seen that overall for New York City, there is less spread among the forecasts within an ensemble–the histogram is tightly spread between 2-3 week leads, whereas for the week prior (Figure 7) there was greater spread in the predicted peak weeks.

2.2 Week 47 Forecast

The week 47 forecast (started November 25, 2012) predicts an outbreak peak in 6-7 weeks for NYC (best at 32 week start), 3-4 weeks in Miami (all have variance of 0.4-0.7, so 40-50% confidence), Chicago in 3weeks (0.3, so 40-50%), Denver in 3 weeks (0.4, 50% confidence), LA 5 weeks (1.3-2 variance, so 20-30% confidence based on region and national), SF 5 weeks (1.8-2 variance, so 20-25%), Dallas, 2 weeks (0.25 variance 50-80% likelihood), Houston (2-3 weeks, 0.3 variance, 50% likelihood), Atlanta in 4 weeks (0.5 variance, 40-60%), Memphis in 3 weeks (0.5 variance, 40-50%).

The distributions for these are shown in Figure 4. The forecasts are, as expected that flu will peak in the south earlier and later in the Northeast and west.

The probabilities/certainties associated with those predictions for those cities are shown calibrated to historical city, regional and national prediction accuracy (Figure 5–city calibration not

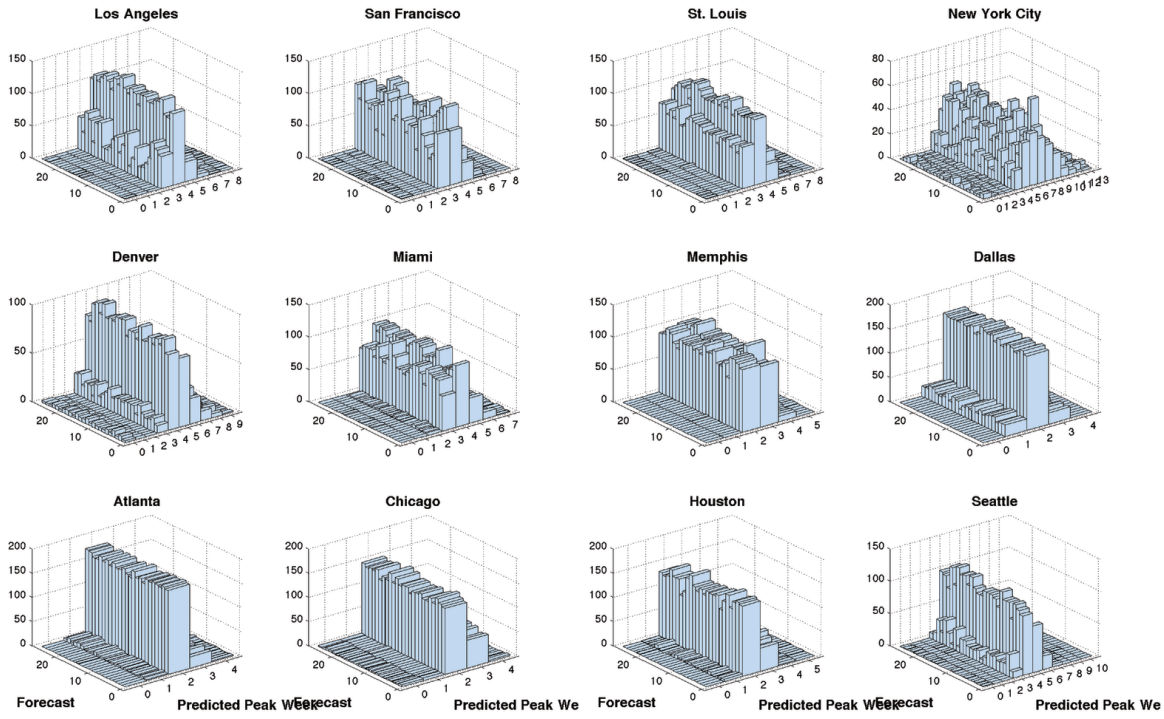

Figure 4: Left) Histograms of the best ensemble start date trainings for forecasts made beginning the start of Week 48 (November 25, 2012) for select cities. The distributions show the ensemble spread among peak predictions. Week 0 is Week 47.

shown). The Atlanta forecasts are very confident based on local and regional calibration. The St. Louis forecast is also very strong (and 4 weeks ahead) based on local and regional calibration.

The 3-week lead forecast for Miami is about 40% regardless of local, regional or national calibration. NYC is at 40-50% confident forecast based on local and regional calibration with a 6 week lead.

2.3 Week 48 Forecast

These forecasts are begun after assimilation of the Week 48 ILI+ observations (week ending December 1, 2012).

The forecasts seems to be consistent with the prior week's in that most have shifted to be one week nearer peak (Figure 6)). Some have jumped more, i.e. St. Louis, which went from 4 to 2 weeks in the future, with a big jump in certainty (90% probability) as calibrated from local and regional baseline historics. Note that all forecasts assume an error of ± 1 week, so a 2-week jump may still represent accurate tracking

Basically, we see predictions of peaking in one week (the week ending December 8, which is today) for Dallas, Chicago and Atlanta, two weeks for St. Louis, Houston, Miami and Memphis, 3-4 weeks for San Francisco, Los Angeles, Seattle and Denver, and 4-5 weeks for NYC–all with varying levels of confidence, though tracking consistently with last weeks forecast (Figure 4).

2.4 Week 49 Forecast – No AH

Week 49 forecasts (again initiated December 9, 2012 at the beginning of Week 50) produce a similar range of predictions (Figure 8). Specifically, Dallas, Atlanta and Chicago are predicted to peak Week 49 (zero weeks in the future). The Dallas forecasts are not always skillful, depending on ensemble spread and whether calibration is to local, regional or national historical relationships between accuracy and spread; however, the Atlanta prediction is very certain. We'll see. These leads agree with the forecast made using the climatological AH forced SIRS model (Figure 2)– though Dallas has a 0-1 week prediction in that case.

Memphis, Houston, St. Louis, and Miami are all predicted to peak in 1 week (Week 50, which is near conclusion at time of writing). Memphis and Houston are in agreement with the climatological AH forecasts; St. Louis is a bit earlier having changed to 1 week from 1-2 weeks with this form; Miami is 1 week earlier with the no AH form. Both shifts are within the margin of error for the predictions (± 1 week).

San Francisco and Los Angeles are predicted to peak in 1-2 weeks with certainties between 30 and 50%. These are a week earlier than the predictions with the climatological AH SIRS form (2-3 weeks). The latter form, produced a few higher confidence predictions for LA at 3 weeks (60-90%, Figure 2).

New York City is predicted to peak in 2 weeks here, in agreement with the climatological AH SIRS forecasts. Seattle and Denver both show 2-3 weeks forecasts for peak week. The Denver forecasts are more certain when calibrated locally. These forecasts are a little earlier than the climatological AH made counterparts (by 1 and 0-1 weeks, respectively, still in the margin of error.)

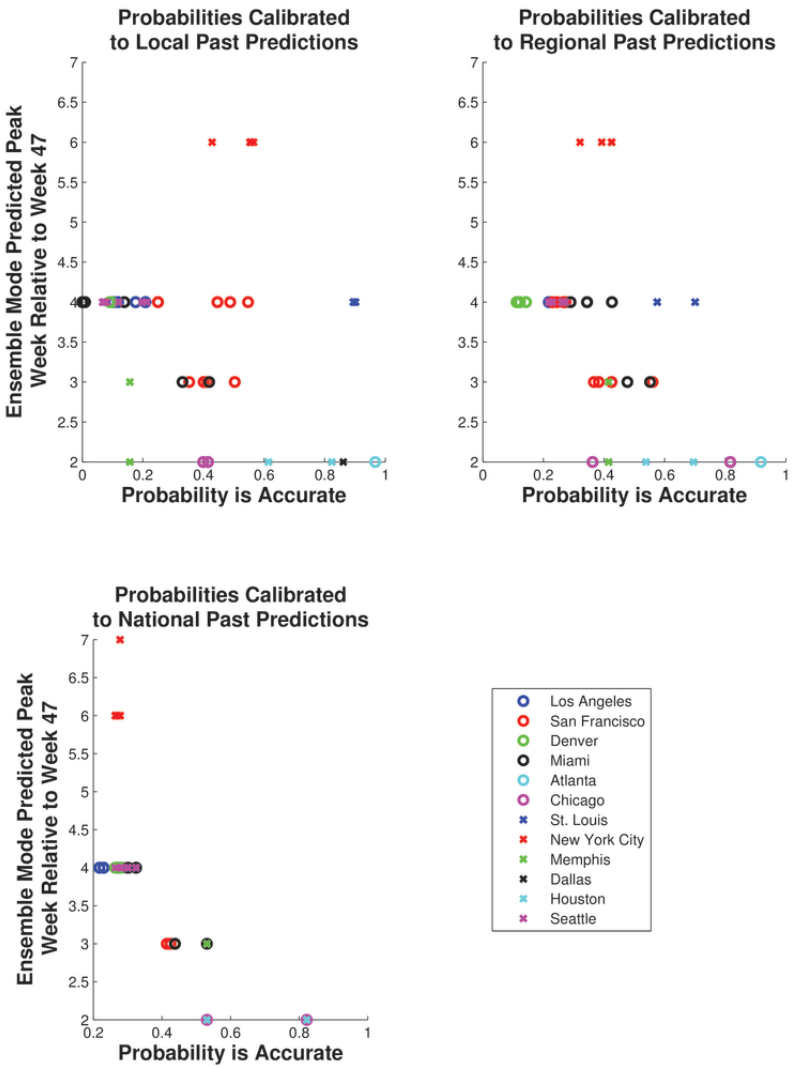

Figure 5: Ensemble mode peak week predictions relative to Week 47 for 12 cities plotted as a function of probability/confidence calibrated from historical city, regional and national prediction accuracy. Forecasts were initiated the beginning of Week 48 (November 25, 2012).

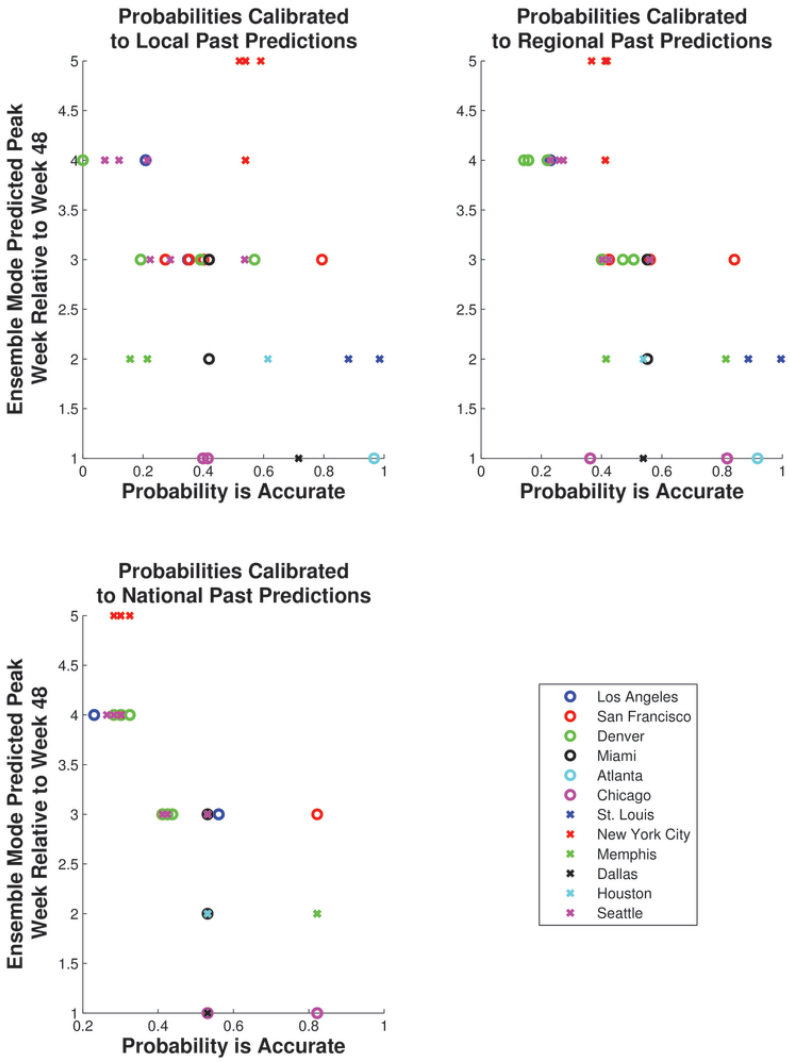

Figure 6: Ensemble mode peak week predictions relative to Week 48 for 12 cities plotted as a function of probability/confidence calibrated from historical city, regional and national prediction accuracy. The forecasts were initiated the beginning of Week 49 (December 2, 2012).

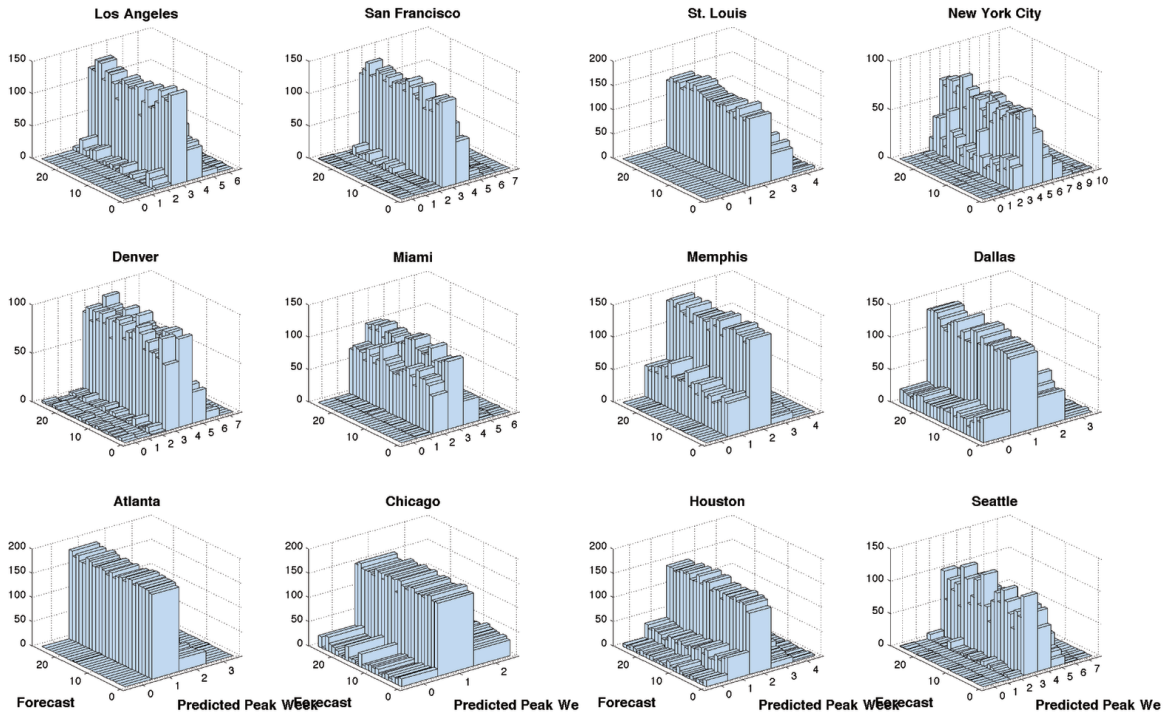

Figure 7: Left) Histograms of the best ensemble start date trainings for forecasts made beginning the start of Week 49 (December 2, 2012) for select cities. The distributions show the ensemble spread among peak predictions. Week 0 is Week 48.

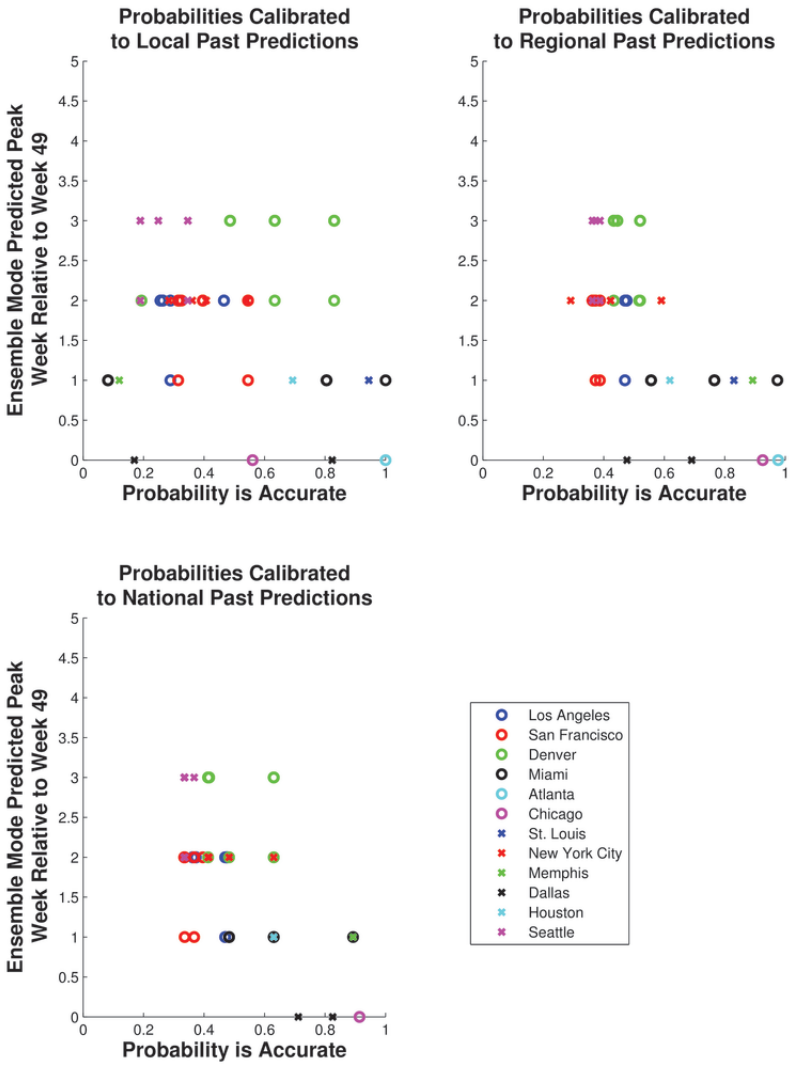

Figure 8: Ensemble mode peak week predictions relative to Week 49 for 12 cities plotted as a function of probability/confidence calibrated from historical city, regional and national prediction accuracy. These are derived from training and forecasts with the SIRS model without AH forcing. Forecasts were initiated the beginning of Week 50 (December 9, 2012).

References

Shaman, J. and Karspeck, A. (2012). Forecasting seasonal outbreaks of influenza. *Proc. Natl. Acad. Sci. U.S.A.*, 109(50):20425–20430.